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SCIENCE

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THE PEDAGOGICS OF PATHOLOGY¹

IN conformity with the established precedent that the presiding office shall be holden for some remarks in inaugurating his term of service, I venture to present some reflections on the pedagogics of pathology. As members of this society, and of the medical profession, we are all interested in the question of medical education, whether engaged or not in actual teaching. In the curriculum of the medical school, pathology occupies a position of especial interest and importance in relation to the other branches. More than any other topic it bridges the gap which at the present time exists between the sciences fundamental to medicine and the clinical subjects.

Pedagogics—the science of teaching methods—has been making rapid progress in the last half century, and has come to occupy a place among the recognized sciences.

Modern pedagogy is of necessity a recent growth, because experimental psychology itself, upon which it is based, is barely forty years old. The first laboratory for experimental psychology was established by Wundt in Leipsic about 1876, while in this country no such laboratory existed until the one opened by Dr. G. Stanley Hall, at the Johns Hopkins University about 1888. Previous to this time, however, important contributions had been made to the teaching art and the ideas of Pestalozzi, of Herbart, of Rousseau, and others were gradually influencing our educational methods. The importance of laboratory or objective methods, the individual-

¹ Address of the President of the Chicago Pathological Society, October 11, 1915.

ization of teaching by closer attention to the peculiarities of the individual pupil, the splitting of large classes into smaller and smaller groups, the elective plan, the continuous session, best exemplified in the quarter system, research as an essential function of the university and as a pedagogic method, the division of the sciences, particularly, into smaller subdivisions, specialization in a word—these and other pedagogic innovations were, and still are, receiving attention from educators, and are being adopted throughout our educational system from the kindergarten onward. Of special importance were the introduction of objective methods of teaching, in field and laboratory, and the recognition of the individual differences of pupils, with the consequent necessity of adjusting the educational process to these differences by some scheme of election or selection of topic, method and teacher in order to secure the best results.

Laboratory methods began to be introduced into the American colleges—on any extensive scale—not much more than half a century ago, at first in chemistry, then in physics and later in the several biologic branches. The supplanting or supplementing of the older didactic methods of lecture and recitation by these laboratory exercises extended rather rapidly in the literary college, but they made their way much more slowly in the medical school. It might have been expected that the contrary would have been the case when it is recalled that for a century or more one laboratory or practical course, that of human dissection, had occupied a recognized place in the medical curriculum, and was required of every student, but it is barely thirty years since any other laboratory course was generally required in the medical college. It is but little over thirty years since the writer attended the two five-months courses of lec-

tures at that time required for graduation in a medical college of the middle west. Coming from a small university, where even at that time the laboratory exercise constituted the most important feature of instruction in all of the sciences, it seemed strange to find no practical work whatever, aside from dissection and a brief four or five weeks' superficial course in chemistry. A year later, having discovered that he was inadequately prepared, it was decided that he should take another course of lectures, and the choice of an eastern medical college was determined by the fact that it alone, of all of the medical colleges in this country, offered a practical or laboratory course in connection with each of the seven departments—chairs, as they were called—which made up the medical college of that day, namely, anatomy, physiology, chemistry, *materia medica*, medicine, surgery and obstetrics. Most of these practical courses were brief and superficial, consisting in large part of demonstrations by the teacher rather than of individual work by the student, but they were the beginning of better things.

The explanation of the tardy adoption by the medical faculty of these modern methods is to be found in the fact that its members were not primarily educators, and they were therefore not keeping closely in touch with the advances in pedagogic methods. They were for the most part, even in the fundamental branches, practitioners of medicine for whom the giving of medical lectures two to four times a week during the five or six winter months was an incidental avocation. Not until the medical schools came to have a real, vital connection with the university, and its faculty was brought in close contact with, and came, in part, to be composed of, men who were making teaching the chief, if not the sole business of their lives, was any considerable

progress made in the introduction of more rational and effective methods.

Pathology in my student days was not recognized as an essential subject in the medical curriculum. Indeed at the first college I attended it was not only not taught, but was ridiculed by some of the most influential members of the faculty, as "Dead-house Medicine." In the second college mentioned, perhaps at that time the most progressive medical college in this country, a few incidental exercises, by a subordinate teacher, who presented some post-mortem specimens to the class, comprised all that was offered. How great has been the advance in the subsequent quarter century is in no wise better illustrated than by the number and character of the contributions made by undergraduate students to the transactions of this society.

Meanwhile, pathology itself has been extending its scope very rapidly. The term pathology no longer stands for mere pathological anatomy, the study of the end results of disease but has come to signify, as its etymology implies, a comprehensive study of the phenomena of disease in the living, the behavior of cells, tissues, organs and systems, in an abnormal environment, or their reaction to abnormal stimuli—an exhaustive search for the causes of these abnormalities, physical, chemical and biologic, and the rationale of the processes by which these etiologic factors bring about the phenomena which we call disease. Indeed, some of the more recent text-books on medicine include, under the heading of pathology, the discussion of etiology, symptomatology, pathogenesis and pathologic anatomy, everything, in short, but diagnosis, prognosis and therapy.

The methods by which this comprehensive knowledge is sought are more and more becoming the methods of exact, carefully controlled experiment on animals. The mere

study of post-mortem changes, important though it is, comes yearly to occupy a relatively less important rôle in the task of the pathologist. Infection and immunity, serology, protozoology, chemical pathology, these and other phases of the subject, newly born in the last decade or two, are rapidly changing our whole conception of pathology, are greatly enlarging its scope, and are, as it seems to me, necessitating a constant readjustment of this branch to other branches in the medical curriculum, and improvements in our methods of instruction by which the coming generation of practitioners must be educated in pathology.

The pedagogics of pathology involves a consideration of (1) its relative importance in the curriculum—that is, the number of scheduled hours that should be assigned to the subject; (2) its proper sequence in the program of courses to be determined by the prerequisites which are essential for its intelligent study, and by its relation to the more advanced clinical subjects for the pursuit of which some knowledge of pathology is necessary, and (3) the methods to be employed in the teaching of the subject, and this depends largely on one's conception of the scope and content of pathology as a science.

A survey of the curricula of about forty of the leading university medical schools of the United States discovers the fact that while there are considerable variations in the courses in pathology offered in these schools, as to the three points just mentioned, on the whole the differences are less marked than are those in the clinical subjects.

The amount of time assigned to the subject is somewhat difficult to determine, as some of the topics taught in most schools under the general heading of pathology, are offered in others in connection with bacteriology, while other topics, for example,

laboratory or clinical diagnosis, are taught in the department of medicine or in other clinical departments. As nearly as can be estimated the time allotted to pathologic topics ranges from 210 hours in one school to a maximum of 504 hours in the University of Ohio.

One of the most conclusive evidences that up to 8 or 10 years ago the principles of pedagogy were little understood or regarded by medical faculties, was the great diversity in the number of hours assigned to the several medical branches. You will recall the rather startling findings of the investigations made as to this matter a decade ago by the secretary of the Michigan State Board of Medical Examiners, the president of the Illinois State Board of Health, and by the Council on Medical Education of the American Medical Association. It was found that the number of scheduled hours assigned to some of the important medical subjects varied by as much as three or four hundred per cent., and that some of the minor subjects, for example, orthopedic surgery, occupied as much of the student's time in some colleges as a major branch like medicine or general surgery.

It is obvious that these curricula were not prepared with any logical consideration of the relative values of the medical branches. Each instructor, impressed with the magnitude of his own subject, clamored for more and more time, insisting that he could not "cover the ground" of his branch of medicine in any number of hours that could in reason be given over to it in a four-year course of study. The construction of a medical curriculum from the point of view of the average student's working capacity and the logical division of his total working hours between the several branches in ratio to their relative importance to the medical practitioner seems not to have been attempted until a very recent period.

When the problem is approached from this standpoint it becomes at once evident that by no possible scheme can such a number of scheduled hours be allotted to any branch as will make it possible for the instructors to completely "cover the ground" of that branch. The task of each department is to make such use of the number of hours assigned to it, by faculty vote, as will secure to each student the largest possible educational result for the expenditure of that time in the given topic. With a curriculum blocked out on such a basis, pathology can not logically demand more than 8 or 9 per cent.—together with bacteriology not to exceed 12 per cent.—of the total number of scheduled hours in the four years' course of study; as this total in the average medical school is approximately 4,400 hours, the time assigned to pathology should not exceed 350 or 400 hours.

I find that the average allotment to the courses in pathology in the curricula of the forty colleges which I have examined is about 350 hours, although there are a few marked exceptions. The time allotted to bacteriology ranges from about 100 to 200 hours, with an average of 150, thus making a total for the two subjects fairly proportionate to their importance in relation to the other branches of the medical curriculum.

The logical sequence of the medical subjects is determined by certain fundamental pedagogic principles.

The study of structure logically precedes the study of function; knowledge of the normal is essential to an understanding of the abnormal, although the study of the latter often yields valuable information about the normal; a broad knowledge of the principles, facts and methods of any growing science to specific problems, as those of medicine, is an indispensable prerequisite if the student is to be so grounded

in that science as to be able to keep abreast with its progress after his student days. It is a fatal error to present the fundamental medical sciences with too exclusive reference to their practical application to medicine and surgery, although the occasional illustration of the bearing of anatomy, physiology, pathology, etc., on their practical application to clinical medicine is of distinct advantage. With these principles in mind the position of pathology in the medical curriculum is not difficult to determine. There is a rather striking uniformity in the place assigned to bacteriology and pathology in the courses of study in the several colleges. In the majority of colleges bacteriology is offered in the first semester of the second year, followed by general pathology in the second semester, and by special pathology, with autopsies, in the third year. In a few institutions bacteriology is given in the first year, and in two instances pathology proper is begun at this time. In a number of colleges advanced pathology with autopsies, and special topics such as surgical, gynecologic, neurologic and dermatologic pathology are continued into the senior year.

Bacteriology, it seems to me, might, with advantage, be divided into two parts, general bacteriology, with laboratory technique, being given in the first year, or better still, required for admission, to be followed by a briefer course in the pathogenic bacteria, and in infection and immunity, in the second year—preferably the first semester. The fundamental course is an excellent one for the beginning student, no work in the other sciences being prerequisite for the intelligent study of the subject, and the laboratory technique affording a good training for the laboratory exercises in the other branches. It seems impracticable to crowd such a course into the two years of premedical work at present demanded by most

schools, but it is probable that this minimum amount can, before long, be extended to three years, and thus provide time for bacteriology.

The position of general pathology in most curricula is as it should be. It secures to the student the necessary preparation in anatomy, gross and microscopic, embryology, physiology, biologic chemistry and bacteriology, and, on the other hand, links these subjects closely to the clinical branches. I would urge, however, the importance of placing pathologic anatomy with autopsies later than is now done in many schools. The student should have acquired some considerable first-hand knowledge of the phenomena of disease in the living patient before he studies the final outcome of serious disease as disclosed at the autopsy, and as often as possible he should follow the individual patient, dying from some affection, which he has observed in life, to the post-mortem table. Of especial educational value is the study of a few cases, seen at autopsy, exhaustively, by every feasible method of examination, as contrasted with a second-hand survey of the whole field of pathologic anatomy by lecture, text-book and recitation. One of our members, not long since, described his own method of conducting such a course, which seems to me in every way commendable.

May I, in this connection, comment on the singular and widely prevalent perversity with which teachers in all lines and grades of education in this country are prone to get away, in their practise, from the fundamental idea and purpose of education?

Its primary purpose is to develop the mental facilities, *not* to impart information. And this is quite as true of medical as of any other kind of education. That the pupil shall be educated, trained to observe

accurately, and thoroughly, to record his observations clearly and concisely, and to reason logically from his findings to sound deductions—that is the main purpose and function of any educational process, be it medical, pathologic or any other. We in America seem especially obtuse in our failure to recognize this vital truth, as is shown conspicuously in the character of our examinations. We have made some progress in our teaching methods, though we have yet much to learn, but we continue to test the results of our work by methods a half century out of date. In examinations for graduation, for licensure to practise (with exceptions now in a few states) and in competitive examinations for internships in the best hospitals, the papers set are wholly written papers of such sort as to test only the volume of facts which the candidate has been able to cram into his cranium—a test, in other words, of but one mental faculty, the memory, and that by no means the most important. Into the student's real power to see and hear and feel things, to know what he observes, and to draw sound conclusions from his findings—in short his ability to do the things he is to be called upon to do as an interne and a practitioner of medicine, we make no real inquiry whatever. If we are to give our students the proper conception of what they are attending the medical school for, and an effective stimulus to really develop all of their mental faculties, along medical lines, we must radically change the character of our examinations.

The teachers of pathology are in an especially advantageous position to set an example in this regard, and to exert a profound influence for the betterment of our methods of examination.

Another serious mistake is the growing tendency to crowd some of the clinical subjects into the sophomore year. In one

school, for example, courses in medicine, surgery, obstetrics, ophthalmology and dermatology now occupy a considerable portion of the time of the second semester of the sophomore year; at another, the sophomores take medicine, both clinical and didactic, surgery and pediatrics; at a third school, medicine, surgery, obstetrics and dermatology occupy 10 hours weekly of the 25 or 30 available, while in yet another, medicine, surgery and obstetrics are begun at this time. The time available for the fundamental sciences of anatomy, general pathology, etc., is all too short when the full time of the two years is devoted exclusively to them. The education which the student is obtaining in these fundamental subjects in these two years is the only systematic instruction he will ever get in those branches, and must serve him for a life time. Most students leave the medical college at graduation with a resolve to review these branches from time to time, but very few indeed ever do so. Deficiencies in clinical training are readily amended, because the subjects are right in line with the physician's daily work; shortcomings in the fundamental branches can be corrected only at a considerable sacrifice of time, money and energy.

I have indicated that I would lay much less stress on pathologic anatomy than has been and still continues to be the custom in most schools, and more, increasingly more, time on experimental pathology, chemical pathology, serology, and the other newer developments of the subject. As to pathologic anatomy much can be done to familiarize students with the gross and microscopic appearance of diseased tissues and organs (and this with the minimum expenditure of effort by both student and teacher) by having displayed in a well-lighted central place, frequented by the student body for study or lounging, patho-

logic specimens, plates, drawings, charts and other illustrative materials. In idle moments one can accumulate a large amount of information by this means. It is the height of stupidity to lock up material of this sort in dark inaccessible cases, to be brought forth only on special occasions.

There is need, in most schools, of a better correlation between the department of pathology and the clinical departments. The clinical teachers are, for the most part, busy practitioners having little time, even when they have the inclination, to keep in touch with what is going on in the pathological department so as to command the resources of its museum in their clinical teaching. The instructors in pathology can accomplish a great deal to secure more thorough and accurate presentation of the pathologic side of the clinical subjects if they are constantly calling the attention of the clinicians to the materials in their museums and laboratories, and are themselves available at convenient hours to respond to a summons to the medical, surgical or other clinic to demonstrate pathologic specimens, illustrative of the topic being presented, or the clinical patient who is being shown, and to explain the newer, more refined laboratory methods of diagnosis.

No colleague of mine would think it possible for me to get through a discussion on an educational topic without allusion to the elective system. I should be sorry to disappoint any one, or to lose such an opportunity. May I say then first, that after fifteen years of experience and observation I am more confirmed in my belief than ever before, of its applicability to, and its advantage, with suitable restrictions, in medical education. The elective principle has been adopted, and is in operation, in one form or another, in every college and university of any importance in this country.

It has been an integral part of the educational system in the German, and most other foreign universities, in the medical as well as in other departments, for over fifty years. I have elsewhere described the plan and discussed its advantages in the medical curriculum at length, and do not here purpose to review that discussion. However, to correct certain erroneous impressions, which seem to be quite prevalent, may I say that the elective system, properly administered, does not mean the unrestricted freedom of the student to do just as he pleases—to choose any course of study which strikes his fancy. Its chief advantages do *not* lie in the choice of branches or even of topics, but much more in the choice of methods of study—by lecture, recitation, laboratory, clinic, research—and of the instructor under whom each course is to be pursued. Its purpose in the medical school is *not*, or should not be, to encourage or even to permit, the undergraduate student to follow a restricted course of study in preparation for a special line of practise, although in this form it is in operation, mistakenly, as I believe, in two or three of our leading medical schools. It does *not* mean, for example, that any student should be permitted to neglect pathology, or medicine or any special clinical subject. It does make for his opportunity to get the minimum amount to be required of that subject by the method and under the instructor that will insure for him the best training, that is the maximum educational gain in that branch of study, and it should permit and encourage him to pursue that subject much beyond the minimum amount required for graduation, if he finds therein, as very many students do, the best medium for developing his powers of observation and reasoning.

As surely as individuals differ, as they do differ widely, in mental equipment and

capacity, just so surely can we obtain the best results in education only by such elasticity in our methods as makes possible the adjustment of the educational procedure to each student's capacity, peculiarities and needs.

And finally, I would speak for a much wider adoption and extension of the method of research in medical education. The daily practise of medicine, for which we are preparing most of our pupils, is research of the highest order and the most difficult type. We train the neuro-muscular apparatus and the special senses to efficiency in any particular direction, by their constant exercise in that activity or direction. How can we better train the mental facilities for research at the bedside than by their exercise in research, in laboratory and clinic? No one would deny that a certain body of fundamental facts and principles must be memorized by every medical student, and facility in certain technical procedures ought to be acquired, but if we hope to arouse in the student a real enthusiasm for his work, and to develop his power of independent initiative and accomplishment in the setting and the solving of problems, it can be done only—certainly most effectively—by setting him to the task of solving problems within his capacity, involving factors within his control, his work being carried on under intelligent, wise supervision. The problems of pathology are peculiarly well adapted for this purpose. They may be so selected as to have to do with materials and factors within the scope of his ability and training, and they are of interest to him because he can readily see their bearing on clinical medicine, for which he feels he is fitting himself. If he is to have zeal in their pursuit, however, it must not be the threshing over of old straw, but new problems whose solution he feels may constitute a real contribution, however small,

to medical science. If he can then present the results of his efforts to a dignified, earnest group of his elders, such as assemble at the meetings of this society, it means for him a generation of enthusiasm, a development of real power, such as no other educational method can produce.

This society has great reason to be proud of the subsequent work of many men and women who found here their first opportunity and their best inspiration. It is certain to have increasing cause for gratification, as the years go on, in the results of this phase of its activities.

JOHN MILTON DODSON

PLANT MORPHOLOGY¹

I PROPOSE to deal with some aspects of the study of plant morphology. In doing so I shall not accept any definition of morphology that would separate it artificially from other departments of botany. I regard the aim of plant morphology as the study and scientific explanation of the form, structure, and development of plants. This abandons any sharp separation of morphology and physiology, and claims for morphology a wider scope than has been customary for the past fifty years. During this period the problem of morphology has been recognized as being "a purely historical one," "perfectly distinct from any of the questions with which physiology has to do," its aim being "to reconstruct the evolutionary tree." The limitation of the purpose of morphological study, expressed in these phrases from the admirable addresses delivered to this section by Dr. Scott and Professor Bower some twenty years ago, was due to the in-

¹ From the address of the president of the Section of Botany, Manchester meeting of the British Association for the Advancement of Science.